



**QUEEN'S  
UNIVERSITY  
BELFAST**

## **Phase Conjugation Technology for Wireless and Imaging (Keynote Address)**

Fusco, V. (2014). *Phase Conjugation Technology for Wireless and Imaging (Keynote Address)*. Paper presented at 17th Research Colloquium on Communications and Radio Science into the 21st Century, Dublin, Ireland.

**Document Version:**  
Peer reviewed version

**Queen's University Belfast - Research Portal:**  
[Link to publication record in Queen's University Belfast Research Portal](#)

### **General rights**

Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

### **Take down policy**

The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact [openaccess@qub.ac.uk](mailto:openaccess@qub.ac.uk).

## **Phase Conjugation Technology for Wireless and Imaging (Invited)**

***Vincent Fusco***

ECIT Research Institute  
School of Electronic and Electrical Eng. and Computer Science  
Queens University Belfast  
v.fusco@ee.qub.ac.uk

In this paper the author will summarize the work at QUB on phase conjugation technology at microwave frequencies. The talk will include a discussion on the principles of Self Tracking Phase conjugate systems. Applications of the technology will given for physical layer secure Terrestrial Mobile to Satellite Broadband SatCoM terminals, for close defense RADAR, sub-wavelength limit imaging and sensor communication including wireless powering in multipath rich or blocked line of sight environments.

Phase conjugating antenna arrays can dramatically improve the functional characteristics of wireless communication systems due to their intrinsic auto-correcting and auto-phasing properties, [1]. The study of phase conjugating (PC) antenna arrays for microwave wireless communications using retrodirective arrays has been reported in [1-3], and their inherent physical layer security properties discussed in [4]. The fundamental feature of this technology is that a two-way communication link is possible when a pilot tone is present and the retrodirective array acts as a phase conjugating mirror capable of encoding (on re-transmit) and or extracting (on receive) data.

A radar system constructed using this technology has the ability to automatically switch from surveillance mode to tracking mode when presented with a target. The acquisition time for such a system is much faster than for a conventional phased array system making it particularly useful in the detection of fast projectiles launched close in, [5].

In addition phase conjugation technology at microwave frequencies lends itself to the creation of active lenses which have the ability to image in both the near and far fields and to concentrate energy into very tight localised regions allowing the possibility for (i) sub-wavelength imaging, [6], and (ii) efficient wireless sensor communication including wireless power delivery in multipath rich environments, [7].

More details on the work to be presented can be found in the references above. It is hoped this talk will encourage others to develop an interest in this topic.

### References

- [1] V. F. Fusco, S. L. Karode, "Self-phasing antenna array techniques for mobile communications applications", *IEE Electron. Commun. J.*, 1999, 11, no. 6, pp. 279–286.

- [2] V. Fusco, N. Buchanan, "Retrodirective array performance in the presence of near field obstructions", *IEEE Trans. Antennas Propagat.*, vol. 58, no. 3, March 2010, pp. 982 – 986.
- [3] N.B. Buchanan, V. Fusco, "Bit Error Rate performance enhancement of a retrodirective array over a conventional fixed beam array in a dynamic multipath environment", *IEEE Trans. Microwave Theory Techniques*, vol. 58, no. 4, 2010 , pp. 757– 763.
- [4] V. F. Fusco, N. B. Buchanan, "Retrodirective antenna spatial data protection", *IEEE Antennas Wireless Propagat. Letters*, vol. 8, 2009, pp. 490 – 493.
- [5] Fusco, V, Buchanan, N, Retrodirective Array Based RADAR Front End Technology (Invited Paper), European Conference on Antennas and Propagation 2010, 12-16 April 2010, Barcelona.
- [6] Fusco, V, Malyuskin, O, Dual-sided Phase Conjugating Surface Techniques for Imaging (Invited), 7<sup>th</sup> European Radar Conference, Sept. 2010, Paris, pp 296-299.
- [7] Chan, P, Fusco, V, Co-operating Retrodirective System, *IET Microwaves, Antennas and Propagation*, 2013, Vol.7, No.3, pp187-194, DOI 10.1049/iet-map.2012.0409.

**Vincent F. Fusco** PhD, DSc, MRIA, FREng, IEEE Fellow, FIET, CEng

Vincent Fusco is Professor of High Frequency Electronics at Queens University Belfast where currently he serves as director of the High Frequency Laboratories. His research interests include active antenna and front-end MMIC techniques. He has published over 400 scientific papers in major journals and international conferences, and is the author of two textbooks. He holds patents related to self-tracking antennas and has contributed invited chapters to books in the fields of active antenna design and electromagnetic-field computation. In 2012 he was awarded the IET senior achievement award, the Mountbatten Medal, for his services to the UK electronics industry.